cooling towers, as well as to new cooling towers. The modification of existing towers may in fact be the main application area of the invention.

The present invention also provides for a degree of readily controllable variation of cooling tower performance to be obtained.

SUMMARY OF THE INVENTION

Surprisingly, it has been found in suitable cases to be feasible and worthwhile to economically enhance the performance of large natural draft cooling towers having a circular cross-section by providing for augmentation of the natural draft by a rotating impeller (fan) within the cooling tower structure which in use spans substantially the whole internal diameter of the cooling tower, or a large proportion thereof. Cooling towers to which the invention is applicable include, in particular, those of such large size that the use of fans to provide or augment the draft of air has been considered impractical or too expensive to be cost-effective, particularly in retrofit applications. The invention is applicable to both new and existing cooling towers, but offers in particular the possibility of upgrading an existing cooling tower without greatly affecting the packing, and requiring comparatively limited space for new equipment inside and outside the existing structure.

According to the invention, there is provided, in a first aspect, a method for enhancing the performance capability of an existing wet type natural draft cooling tower, wherein the cooling tower:

(a) is adapted including by size and cooling capacity in natural draft operation for use as a natural draft cooling tower in electric power generating station application,

(b) includes a structure defining an internal passage of circular cross-section for the upward convectional flow of an air stream therein from air inlet openings at or near a lower part of the structure to an outlet opening at the top of the structure, and

(c) contains heat transfer means in a lower part of said passage for transferring heat from water supplied to said cooling tower to said air,

and wherein said method includes the steps of:

providing within said passage an impeller adapted when rotated at a specified speed about an upright axis of rotation centrally located in said passage

in a specified operating condition of said tower to increase the flow rate of air in the passage beyond an overall flow rate obtainable in identical operating conditions by natural draft alone;

providing support means adapted for supporting said impeller within said passage above said heat transfer means; and

providing drive means capable of rotating said impeller at said specified speed.

In a second aspect of the invention, there is provided apparatus for enhancing the performance of a wet type natural draft cooling tower, said apparatus being adapted to use in a cooling tower that:

(a) is adapted including by size and cooling capacity in natural draft operation for use as a natural draft cooling tower in electric power generating station application,

(b) includes a structure defining an internal passage of circular cross-section for the upward convectional flow of an air stream therein from air inlet openings at or near a lower part of the structure to an outlet opening at the top of the structure, and

(c) contains heat transfer means in a lower part of said passage for transferring heat from water supplied to said cooling tower to said air,

and said apparatus including:

an impeller adapted when rotated at a specified speed about an upright axis of rotation centrally located in said passage in a specified operating condition of said tower to increase the flow rate of air in the passage beyond an overall flow rate obtainable in identical operating conditions by natural draft alone;

support means adapted for supporting said impeller within said passage above said heat transfer means, and

drive means capable of rotating said impeller at said specified speed.

In a third aspect of the invention, there is provided a wet type natural draft cooling tower for cooling a liquid and having a cooling capacity variable by a user, said cooling tower:

(a) being adapted including by size and cooling capacity in natural draft operation for use as a natural draft cooling tower in electric power generating station application,

(b) including a structure defining an internal passage of circular cross-section for the upward convectional flow of an air stream therein from air inlet openings at or near a lower part of the structure to an outlet opening at the top of the structure,

(c) containing heat transfer means in a lower part of said passage for transferring heat from water supplied to said cooling tower to said air, and

(d) including apparatus as disclosed above and herein for increasing the cooling capacity of said cooling tower when in operation.

In a fourth aspect of the invention, there is provided a method for enhancing the performance of a power generation plant in which:

steam is passed through a turbine which drives an electric power generator and said steam is condensed in a condenser;

cooling water for said condenser is circulated through said condenser and a wet type natural draft cooling tower;

said method including the steps of:

adding to said cooling tower apparatus for enhancing the performance of said cooling tower, said apparatus being apparatus as disclosed above or herein; and

operating said apparatus.

Further preferred further features of the invention are set out in both the appended claims and the detailed description below.

The invention will now be described in more detail, although without any intention to limit the scope of the invention, by reference to the attached Figures, of which:

Figure 1 is a schematic steam/water circuit diagram of a simplified electric power generating installation;

Figure 2 is a side view of a counterflow-type, "hyperbolic" natural draft cooling tower, seen in vertical cross section, the section being taken at the symmetry axis of the tower structure;

Figure 3 is a side view of a crossflow-type, "hyperbolic" natural draft cooling tower, seen in vertical cross section, the section being taken at the symmetry axis of the tower structure;

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

1. A method for enhancing the performance capability of an existing wet type natural draft cooling tower, wherein the cooling tower:

(a) is adapted including by size and cooling capacity in natural draft operation for use as a natural draft cooling tower in electric power generating station application,

(b) includes a structure defining an internal passage of circular cross-section for the upward convectional flow of an air stream therein from air inlet openings at or near a lower part of the structure to an outlet opening at the top of the structure, and

(c) contains heat transfer means in a lower part of said passage for transferring heat from water supplied to said cooling tower to said air,

and wherein said method includes the steps of:

providing within said passage an impeller adapted when rotated at a specified speed about an upright axis of rotation centrally located in said passage in a specified operating condition of said tower to increase the flow rate of air in the passage beyond an overall flow rate obtainable in identical operating conditions by natural draft alone;

providing support means adapted for supporting said impeller within said passage above said heat transfer means; and

providing drive means capable of rotating said impeller at said specified speed.

2. A method according to claim 1 wherein said heat transfer means includes a packing structure having surfaces arranged to be wetted externally by said water so that heat is transferred from said water by evaporation of a proportion of said water into said air.

3. A method according to claim 1 or 2 wherein said impeller when rotating at said specified speed spans substantially the entire diameter of said passage at the height of the periphery of said impeller save for a suitable operating radial clearance between said impeller and an internal surface of said passage.

4. A method according to any one of claims 1 to 3 including the step of securing said support means to at least one of a foundation and a support structure of said packing structure of said cooling tower.

5. A method according to any one of claims 1 to 4 wherein one said impeller only is provided in said passage.

6. A method according to any one of claims 1 to 5 wherein said impeller is supported by said support means at a height in said passage at least approximately corresponding to the minimum cross-sectional area of said passage.

7. A method according to any one of claims 1 to 4 wherein said impeller is supported by said support means at a height in said passage below a height at which said passage is of minimum cross-sectional area.

8. Apparatus for enhancing the performance of a wet type natural draft cooling tower, said apparatus being adapted to use in a cooling tower that:

(a) is adapted including by size and cooling capacity in natural draft operation for use as a natural draft cooling tower in electric power generating station application,

(b) includes a structure defining an internal passage of circular cross-section for the upward convectional flow of an air stream therein from air inlet openings at or near a lower part of the structure to an outlet opening at the top of the structure, and

(c) contains heat transfer means in a lower part of said passage for transferring heat from water supplied to said cooling tower to said air,

and said apparatus including:

an impeller adapted when rotated at a specified speed about an upright axis of rotation centrally located in said passage in a specified operating condition of said tower to increase the flow rate of air in the passage beyond an overall flow rate obtainable in identical operating conditions by natural draft alone;

support means adapted for supporting said impeller within said passage above said heat transfer means, and

drive means capable of rotating said impeller at said specified speed.

17. Apparatus according to claim 16 including means whereby each blade assumes said further position when said impeller is stationary.

18. Apparatus according to any one of claims 15 to 17 further including protection means securable to an internal surface of said passage at a position such that when said impeller is rotating at said specified speed, said protection means is adjacent to the outer end of each said blade and adapted to limit damage to said internal surface due to flinging of moisture from said blades.

19. Apparatus according to any one of claims 15 to 18 wherein each said blade has a formation at a radially outer end of said blade adapted to limit flinging of moisture collected on said blade onto an internal surface of said passage when said impeller is in said operative position.

20. Apparatus according to any one of claims 8 to 19 wherein said drive means includes an electric motor.

21. Apparatus according to claim 20 wherein said electric motor is outside said cooling tower structure and arranged to rotate said impeller via a gear train enclosed in a casing in said cooling tower structure.

22. Apparatus according to claim 20 or 21 wherein said electric motor is operable when required as a generator so that if said impeller is rotated by a natural draft within said cooling tower energy can be extracted from said generator.

23. A wet type natural draft cooling tower for cooling a liquid and having a cooling capacity variable by a user, said cooling tower:

(a) being adapted including by size and cooling capacity in natural draft operation for use as a natural draft cooling tower in electric power generating station application,

(b) including a structure defining an internal passage of circular cross-section for the upward convectional flow of an air stream therein from air inlet openings at or near a lower part of the structure to an outlet opening at the top of the structure,

(c) containing heat transfer means in a lower part of said passage for transferring heat from water supplied to said cooling tower to said air, and

(d) including apparatus according to any one of claims 8 to 22 for increasing the cooling capacity of said cooling tower when in operation.

24. A method for enhancing the performance of a power generation plant in which:

steam is passed through a turbine which drives an electric power generator and said steam is condensed in a condenser;

cooling water for said condenser is circulated through said condenser and a wet type natural draft cooling tower;

said method including the steps of:

adding to said cooling tower apparatus for enhancing the performance of said cooling tower, said apparatus being apparatus according to any one of claims 8 to 22; and

operating said apparatus.

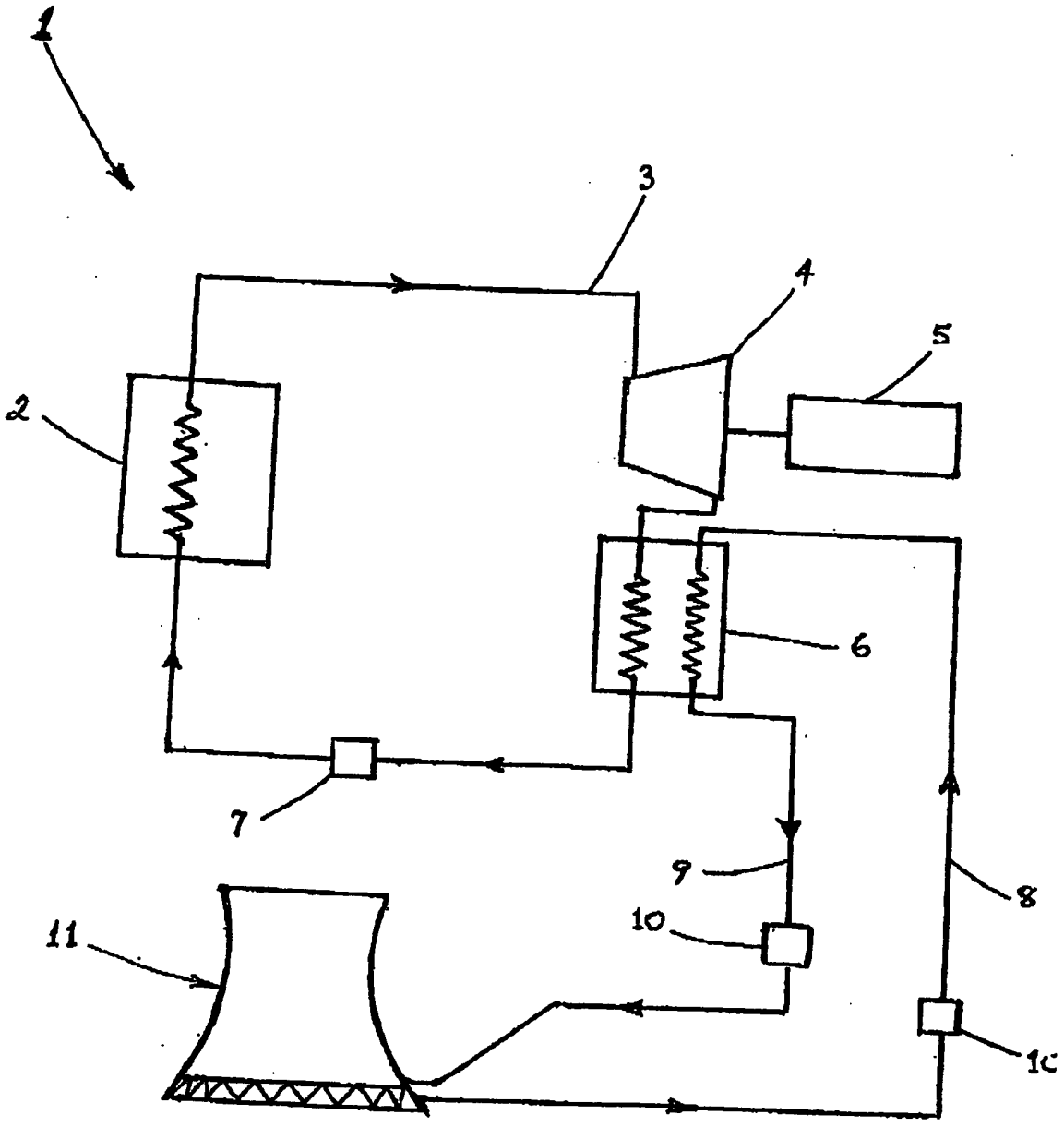

FIGURE 1

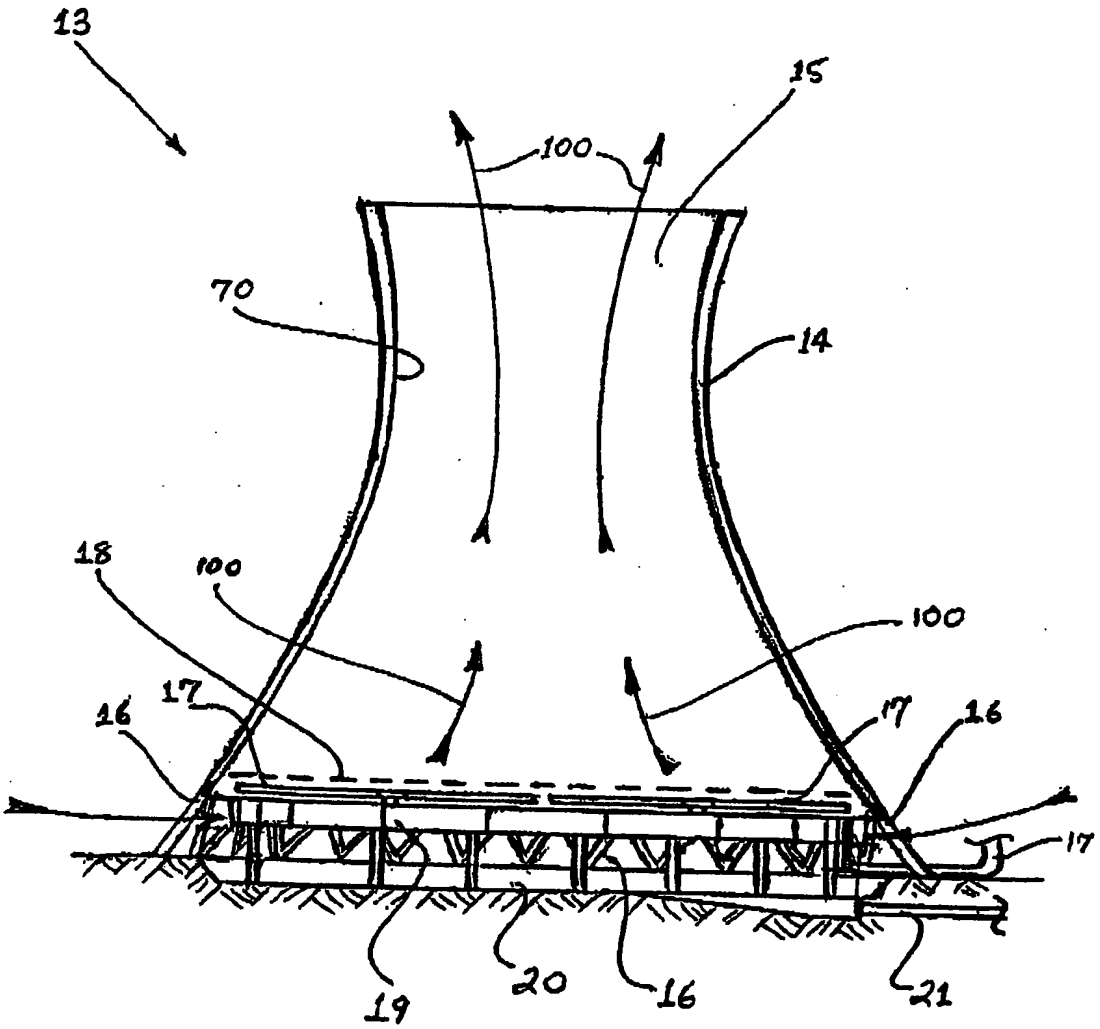

FIGURE 2

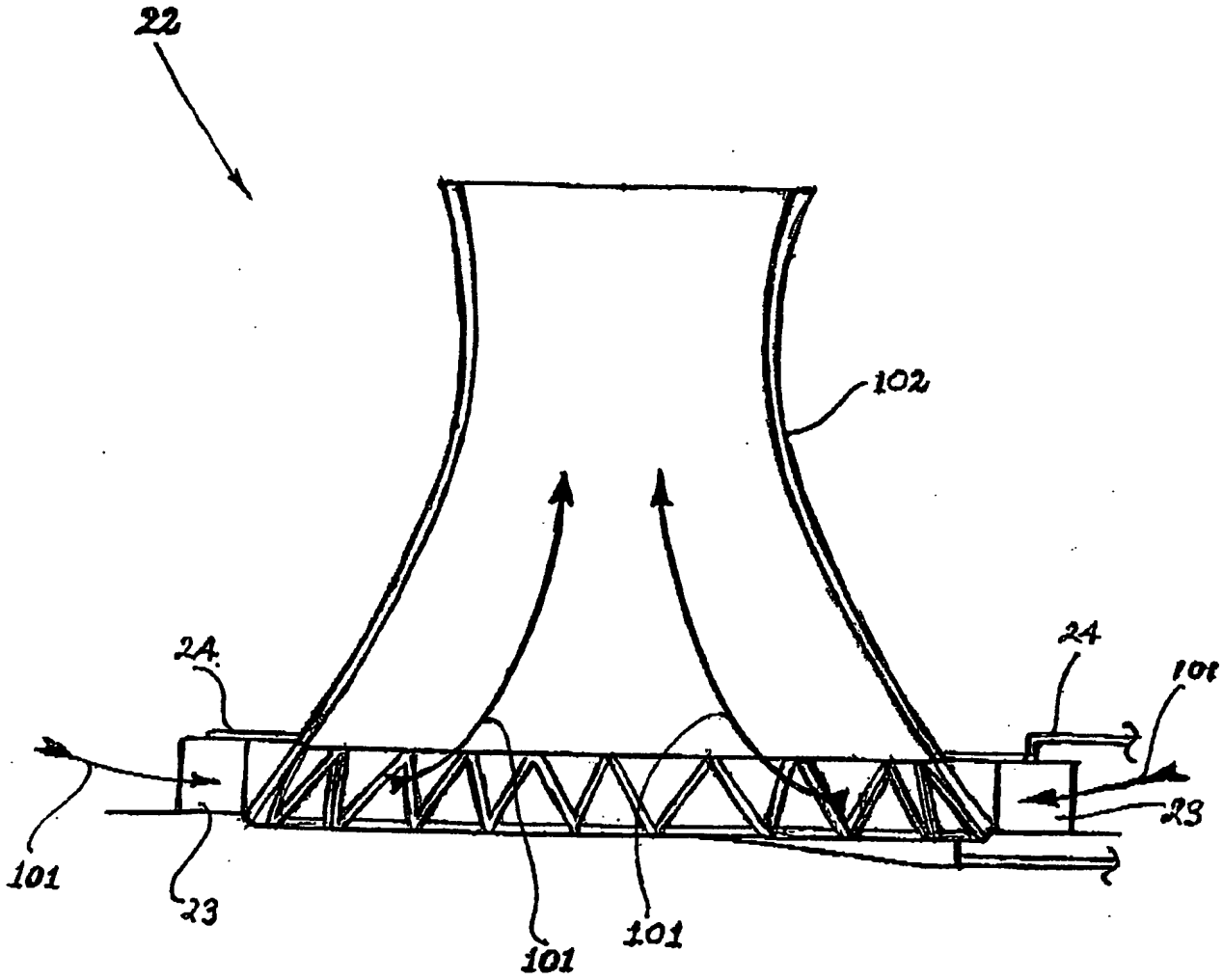

FIGURE 3

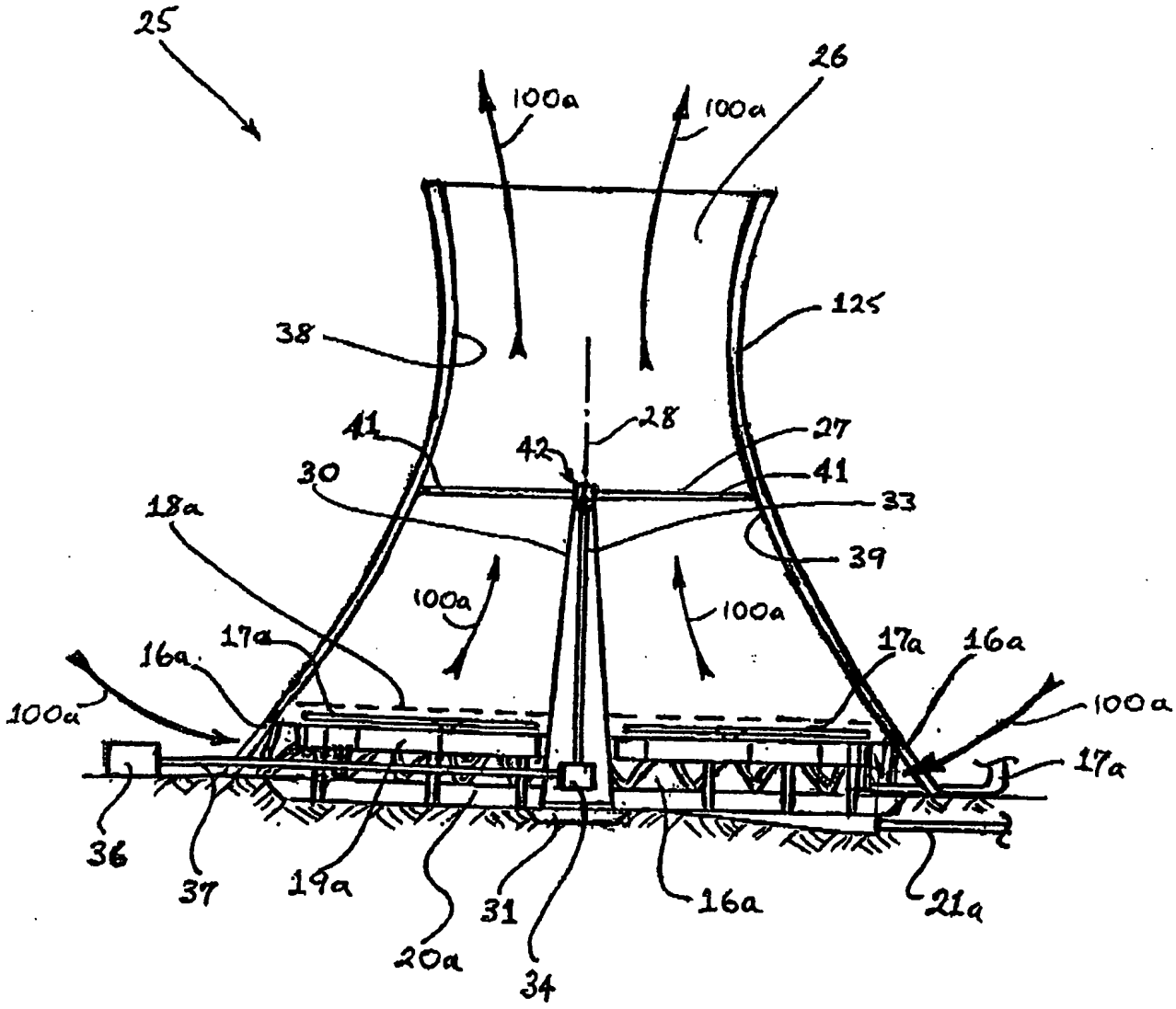
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FIGURE 4

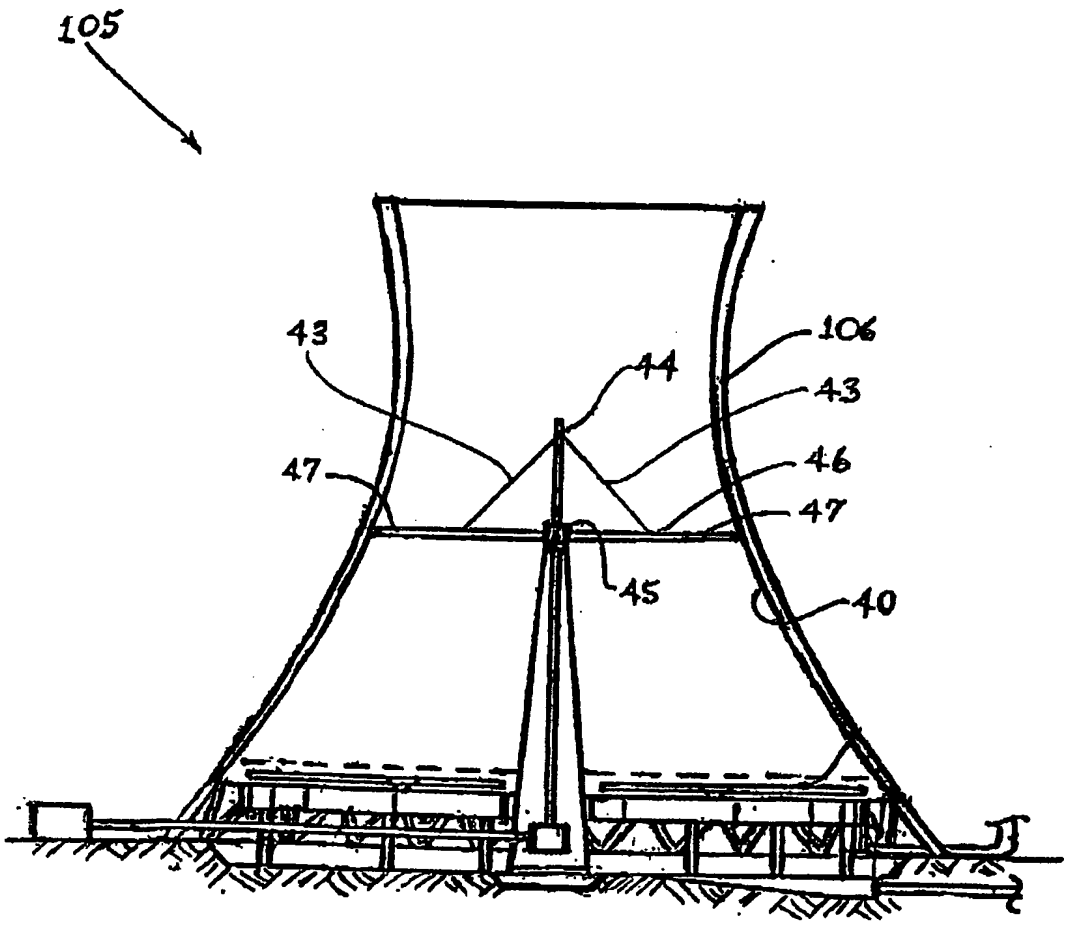

FIGURE 5

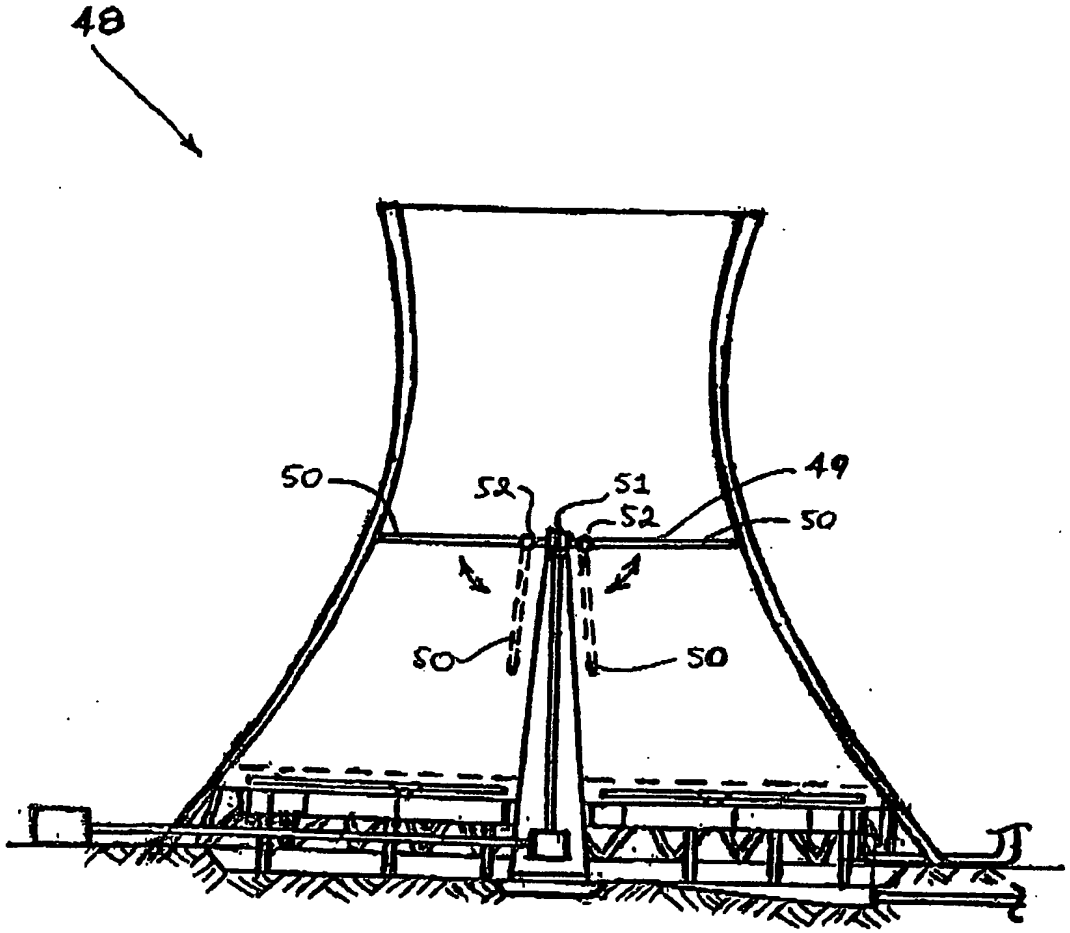

FIGURE 6